

~~electronics-electronic devices.~~

## 2. Description of the ~~Related Art~~ related art

Electronic switching devices are well known in the art ~~several alternate.~~ Several alternative principles are usually ~~utilizes~~ utilized for the purpose of producing electronic switching. One method is MOSFET. It ~~consist~~ consists of a P-p-type semiconductor with two n-type regions, one ~~of on~~ on either end, ~~on~~. On the top surface above the P-p-type region, is a thin layer of oxide insulator; on the surface of this insulator there is a polysilicon gate.

~~By applying~~

When a positive voltage is applied to the central electrode, the positive charge on the gate electrode (p<sup>+</sup> region) repels the holes at on the top surface of the p-type layer. Thermally created conducting electrons in the p-type layer will be attracted by the positive charge. This means ~~that~~ that electrons can flow freely from one side to the other and the device is on. If the voltage is removed, there is no current and the device is off.

Another method is that of the bipolar transistor, ~~a~~. A bipolar can ~~be have~~ have an n-p-n or a p-n-p structure. It is critical that the middle layer (base) be thin for high current gain. Bipolar transistors have restricted current flow. A bipolar transistor can be operated in different various regimes that are ~~determent~~ determined by the biases of the two junctions; the most important of these regimes is the active (normal) mode ~~where, in~~ which the emitter-base junction is forward and the collector-base junction is reversed. In the saturation mode, the collector current  $I_c$  is a weak function of  $I_b$  or  $I_e$ . If the cut-off mode set by  $I_b$  ~~or~~  $I_e$  ~~equals~~ is equal to zero, the transistor is off and  $I_e$  is close to zero. Bipolar transistors are more suitable for high-speed circuits because of their high transconductance. Another advantage of the bipolar transistor is that the threshold for turn-off is less sensitive to process variation. ~~Mosfet-~~ The advantage involved in MOSFET transistors, on the other hand, is their less difficult fabrication process.

The present invention ~~is-concerns~~ concerns a switching devices based on a change in ~~electrie~~ electrical charge distribution ~~denoted~~, which is referred to as wave function size change. The ~~notation of term~~ term "wave function" ~~is referred to wave function defined~~

energy consumption. Another problem is that ~~electron current~~currents have speed limits that set limits to switching time.

#### SUMMARY OF THE INVENTION

~~It is an~~ An object of the present invention is to provide a switching method ~~of with~~ low energy consumption, fast switching time and reduced heat emission for switching in computing, electronics, optoelectronics or any kind of circuit.

~~For~~In one embodiment of the invention, the switching state is dependent on the particle wave function size in space.

~~For one~~In another embodiment of the invention, the method of changing the particle wavefunction size is by means of energy received or transmitted by the particle.

~~For~~In other embodiments of the invention, the switching method ~~is by~~ of changing the particle wave function size is by means of a change in kinetic energy, photonic energy, and potential energy — for example, coulomb potential energy, or phonon energy.

~~For one~~One embodiment of the invention includes a method for detection of the switched-switching state, comprising: two boundaries ~~on~~ on two sides of the switching particle. ~~Wherein~~In that embodiment, the ~~two~~respective switching states ~~state~~ is detected by the corresponding values of the potential between the two boundaries.

~~For one~~One embodiment of the invention ~~include~~includes a silicon layer with phosphorus dopants. ~~An~~, an undoped silicon layer, a silicon oxide insulator layer on two sides of the doped silicon layer, an ~~Aluminum~~aluminum-based metallic contact on the insulator layer, an additional silicon oxide insulator layer and ~~Aluminum~~an aluminum current conductor on said additional silicon oxide insulator layer.

~~For one~~One embodiment of the invention ~~include~~includes a method for detection of the switched-switching state wherein the ~~two~~respective switching states is detected by photon detection.

~~For one~~One embodiment of the invention ~~include~~includes a switching device wherein the switched-switching state depends on the dynamic change of the particle wave function dynamic-size change in space.

~~For one~~

One embodiment of the invention ~~include~~includes a switching device comprising: (a) two conductive planes; (b) an electron which can be switched between two state ~~where~~states whereby, in one state, the particle ~~move~~moves to a region between the two ~~plane~~planes and ~~the~~, in the second state, the particle ~~is moving~~moves outside the region between the two planes, wherein the movement is a translation movement of the ~~all the~~entire particle; (c) the ~~two~~respective state ~~are~~is detected by the difference in the charge potential between the two planes.

Further embodiments of the invention include ~~semiconductor or other materials~~ structures and methods of varying scope involving semiconductors or other materials, as well as apparatus, devices, modules and systems making use of such ~~semiconductor or other materials~~ structures and methods. The term "particle" can refer to a group of

more than one particle, for example, an atom or a molecule.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

~~FIG-Fig.~~ Fig. 1a is a schematic representation of a switching device based on particle wave function size change. ~~Wherein,~~ wherein the particle wave function is in its initial size.

~~FIG-Fig.~~ Fig. 1b is a schematic representation of a switching device based on particle wave function size change, in which the particle ~~increase~~has increased its energy and its wave function size.

~~FIG-Fig.~~ Fig. 2a is a schematic representation of a switching device; the device is switched to the second state by means of a gain in kinetic energy ~~gain~~ from other particles.

~~FIG-Fig.~~ Fig. 2b is a schematic representation of a switching device; the device is switched back to the first state by transferring kinetic energy to other particles.

~~FIG-Fig.~~ Fig. 3a is a schematic representation of a switching device, wherein the switching is based on photon absorption.

~~FIG-Fig.~~ Fig. 3b is a schematic representation of the device and particle state after ~~it absorbed~~absorbing the photons.

~~FIG-Fig.~~ Fig. 4a is a schematic representation of a switching device, wherein the switching to a larger particle wave function state is based on energy gain from phonons.

~~FIG.~~

Fig. 4b is a schematic representation of a switching device, wherein the switching to a smaller particle wave function state is based on particle energy transferred to phonons.

~~FIG-Fig.~~ Fig. 5 is a schematic representation of a switching device based on particle wave function size change, wherein the switching is based on potential energy interaction.

~~FIG-Fig.~~ Fig. 6a is a schematic representation of a switching device, wherein the particle wave function is not large enough to fill the detection zone.

~~FIG. Fig. 6b~~ is a schematic representation of a switching device, wherein the particle wave function fills the detection zone.

~~FIG. Fig. 7~~ is a schematic representation of a switching device, wherein the detection of the switching state is based on photons detection.

~~FIG. Fig. 8a~~ is a schematic representation of a switching device. ~~Wherein,~~ wherein the particle wave function size is static and the current is zero.

~~FIG. Fig. 8b~~ is a schematic representation of a switching device, wherein the continuous dynamic change in the particle wave function size change ~~wherein the continuous dynamic change producing~~ produces a charge current.

~~FIG. Fig. 9a~~ is a schematic representation of a switching device in accordance with another embodiment of the invention. ~~Wherein,~~ wherein the particle is outside the detection zone.

~~FIG. Fig. 9b~~ is a schematic representation of the switching device, wherein the particle is inside the detection zone.

~~FIG. Fig. 10~~ is a schematic representation of a switching device in accordance with another embodiment, wherein the particle wave function influences the current.

~~FIG. Fig. 11a~~ is a schematic representation of a switching device, wherein the particle is in a smaller range in the cavity due to repulsive potential.

~~FIG. Fig. 11b~~ is a schematic representation of a switching device, wherein the particle is in a larger range in the cavity.

~~FIG. Fig. 12a~~ is a schematic representation of a switching device in accordance with another embodiment, wherein the particle wave function is in a smaller range.

~~FIG. Fig. 12b~~ is a schematic representation of the switching device, wherein the particle wave function is in a larger range.

~~FIG. Fig. 13~~ is a schematic representation of a switching device Wherein particles, wherein the particle wave function inside a region of a layer influenced influences the current inside a wire connected parallel to said region.

~~FIG-Fig.~~ 14 is a schematic representation of a switching device, wherein ~~the particle wave function expansion inside a first layer influence~~influences, by means of an ~~electricelectrical~~ potential, the current inside a second layer.

~~FIG-Fig.~~ 15 is a schematic representation of a switching device, wherein ~~the particle wave function expansion inside a first layer influence~~influences, by ~~electricelectrical~~ means of an ~~electrical~~ potential, the current inside a second layer, and the expansion or contraction of said wave function, determined by an electrical potential field ~~influence~~influences the wave function from external charged areas.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment is a switching device based on changes of the ~~particle wave functions~~particle wave function size inside a container, as illustrated in ~~fig-Fig.~~ 1.

The device includes a container 1 (for example, a quantum well-) and a particle wave function 2 or an expanded wave function 3.

The ~~notation-term~~ "container-is referred in-" constitutes a general reference to any kind of zone, which ~~containedcontains~~ most of the particle wave function. The ~~notation-term~~ "particle" can refer to several kind of ~~partieleparticles~~particles, for example: electron, proton, neutron, atom, molecule or photon; the ~~notation-term~~ "particle" may refer to one or more than one particle. Figure. 1 ~~presentpresents~~ a two-dimensional wave function, the ~~absolute-square of the absolute value of the wave function is the probability distribution of finding the particle;~~ the filled area ~~illustrated-illustrates~~ an area where ~~it-is-the particles are most likely to find-the particles-be found;~~ outside the filled area, there is a low probability ~~to-found-of finding~~ the particles. The upper curve of the wave function ~~isrepresents~~ the ~~borderboundary~~ of the area of high probability of finding a particle; it is determined by internal characteristics of the particle wave function mathematically described by a wave packet ~~and-it-determined,~~ as well as by the wave function interaction with other ~~particle-particles~~particles in the container. Changes in the particle wave function size derived from changes in the particle energy in one case increasing the particle energy increases the particle wave function size in the container. Particle-The energy gained energy by the particle could be kinetic energy, potential energy or both. Decreasing the particle energy to its initial value results in revertingrestores the particle wave function size to its initial size. The term "wave function size-referred" refers to volume

distribution on

distribution; on devices that are degenerated to two or one or two dimensions are degenerated, the size can be denoted as plane-planar surface area or length. Particle in ~~fig.~~ The particle in Fig. 1 have ~~has~~ an energy denoted by  $E_1$ ; this particle wave function ~~occupied~~ occupies a certain space in the container, which is indicated as the first ~~switched~~ switching state. If the particle has energy  $E_2$ , where  $E_2 > E_1$ , this ~~caused~~ causes the particle wave function inside the container 1 to expand, indicating the second ~~switched~~ switching state.

The operation of the device is heuristically suggested by ~~fig.~~ Figs. 1, 2. In ~~fig.~~ fig. 2, the device is switched from its initial state, characterized by wave function size 5, to a second state, characterized by a larger wave function size 6 inside the container. ~~The operation of device is heuristically suggested by Fig. 2, fig. 2a~~ consisted of ~~shows~~ a container 4, ~~of where the initial wave function size wave function~~ 5, ~~has changed to an expanded particle wave function size 6 due to a gain in kinetic energy receipt from external interaction as with external particles 7.~~ Fig. 2b ~~shows~~ shows kinetic energy transfer from the particle in container 4 to an external particle 8, which interacted with the particle in the container ~~that caused~~, causing the reduction of the particle wave function to its initial size 5 and switching the device state is switched back to the first state-1. The ~~referred~~ referenced change in the particle distribution is ~~does not by involve classical transnational translational movement~~; it is a quantum mechanics phenomenon that ~~allow~~ allows the particle to have the probability of occupying areas ~~where~~ which it could not ~~occupied~~ occupy by classical ~~transnational translational movement on in a given time and with a given particle energy~~. The switching time between two states can ~~varied~~ vary between ~~nanosecond to femto second~~ nanoseconds and femtoseconds, the energy required to ~~switched~~ switch the wave function of a single electron could be ~~small as low as ten millielectronvolt~~ millielectronvolts at room temperature. A similar device structure described in ~~fig. 3.~~ Wherein, wherein the switching between the two states is achieved by photon absorption or transmission by the switched particle, is illustrated in Fig. 3. The operation of the device is heuristically suggested as particle 9, with an initial energy  $E$  ~~absorbed~~, which absorbs a photon 10 transmitted to the particle 9 by an external source. In ~~fig.~~ Fig. 3b, the energy of particle 9 ~~energy is increase~~ is increased to energy a level of  $E+p$ , where  $p$  ~~denoted~~ denotes the energy due to the photon absorption, ~~which caused~~; this increase in turn causes an increase in the particle wave function size 11. ~~Change~~ The change in the particle wave function size ~~represent~~ represents a change in the device ~~switched~~ switching state. A reverse switching between the two states Switching back to the original state can be achieved by photon emission by the particle wave function 11 or by an interaction with an additional

particle or phonon which reduced the switched particle to its initial energy, size and state 9.

In Fig. 4, the switching between the two states is achieved by phonon or ~~phonons~~ phonon energy exchange with the switched particle. Fig. 4a ~~shows~~ shows an increase in the switching particle wave function size 12 due to energy gain from an interaction with a phonon 13 that transferred energy to the switched particle. The ~~particle~~ expanded particle wave function is regarded as the second switched-switching state of the device. Fig. 4b ~~shows~~ shows the device reverted to its initial state by ~~an energy transmitted as the result of energy transmission from the particle wave function 12 to an interacting phonon or phonons 14 that caused, causing the particle wave function to decrease~~ revert to its initial size and the device to switch back to the initial state.

A similar device structure is illustrated in FIG-Fig. 5 ~~the~~. The switching device includes two charged areas 15, 15a ~~in on~~ two sides of the switching particle 16.

The operation of the device is heuristically suggested by a particle wave function 16 ~~indicated~~ indicating a device switched-switching state; ~~the~~ charged areas 15, 15a are used for detection of the device states; ~~for~~. For a charged particle like ~~such as an~~ electron, the particle probability distribution is also the charge probability distribution. A change in the charge probability distribution ~~change~~ changes the electric field and ~~electric~~ electrical potential on the detection element ~~which~~; this is detected as a change in the switched-switching state. In this embodiment, the potential value between the two charged areas 15, 15a is different when the particle wave function 16 in the container ~~has~~ is smaller or ~~bigger~~ larger in size, which ~~indicated the two~~ switched states of device respectively indicates the two switching states of the device.

In ~~figure~~ Fig. 6, the device has two regions determined by their material composition ~~in~~. In region 17, the device is made of silicon with dopants ~~like phosphors~~ such as phosphorus, or made of ~~an~~ insulator like ~~Al<sub>sub</sub>2O<sub>sub</sub>3~~ such as Al<sub>2</sub>O<sub>3</sub>. Region 18 is made of silicon. The potential detector is made of two charged areas 19, 20 on two sides of region 18.

The operation of the device is heuristically suggested by Fig. 6: -The device can be switched between two states. The first state is when the particle wave function is only in region 17; ~~the~~ second state is when the particle wave function ~~has~~ expanded to region 18 as well, ~~the~~. The particle wave function is expanded by a kinetic energy ~~gained to gain in the particle and; it is returned to its initial value when the particle kinetic energy returned to its initial value~~ when the particle kinetic energy returns to



its initial value.

The two ~~switched-switching~~ states are detected by the potential difference between the two zones 19, 20, located on ~~opposites~~ opposite sides of region 18, as the ~~electric~~ expansion of the electrical charge expanded to region 18 would change the electric ~~changes the electrical potential between elements~~ elements 19, 20.

~~Device in fig.~~ The device in Fig. 7 is similar to ~~the device in figure~~ Fig. 6, but with ~~optic~~ optical detection based on photon scattering 21 or photon absorption 22 or photon transmission 23 of the particle wave function 24. The detector 25 can be in different places near the container, depending ~~ifon~~ whether the detection is derived from scattering, absorption or transmission.

The operation of the device is heuristically suggested by Fig. 7. The device can be switched between two states. The first state is when the particle wave function is only in the lower region ~~border by lined~~ bounded by the dashed line; the second state is when the particle wave function is expanded by kinetic energy gained in the particle; it is returned to ~~it's~~ its initial value when the particle kinetic energy ~~returned~~ returns to its initial value. The two ~~switched-switching~~ states are detected by optical means that ~~corresponds to particle in accordance with the particle occupancy distribution when~~ When the wave function is in the expanded state, there is a higher probability for of particle occupancy in the optical detection region 21 or 23 the; this could be indicated in grater as greater absorption or scattering of photon photons, thereby indicated a referred switched state indicating one referenced switching state. while the second ~~switched-switching~~ state could be indicated by lower absorption, less scattering or higher transmission derived from a contracted particle wave function.

~~Second~~ An additional preferred embodiment is a consists of the switching device illustrated in?

~~Fig. 8 the.~~ The device ~~include~~ includes a particle wave function 26, inside a container 27, and a detection element 28.

The operation of the device is heuristically suggested by a kinetic energy gain ~~by in~~ in the electron wave function 26 ~~in container 27 that caused,~~ causing expansion of the quantum mechanics wave function and electric the electrical charge distribution expansion, the. The expansion is aa continuous dynamic continues ~~process that influenced which affects the electrons on conductor 28 and caused causes~~ conventional electron conduction in 28. The ~~switch~~ switching state is determined by the current value in 28. The ~~continues~~ continuous expansion is

~~Differ~~different from ~~transnational~~translational movement ~~for~~. For example, the center of mass

~~Of~~ of the particle can move less ~~over a smaller~~ distance in expansion mode, compared to ~~transnational~~the translational movement obtained by averaging the probability distribution of the particle mass.

~~Third~~

A third preferred embodiment ~~is a~~ consists of the switching device illustrated ~~fig in~~ Fig. 9

The device ~~contain~~includes a particle 32, two electrically influenced planes 29, 30 And ~~and a~~ container 31.

~~Two~~ Fig. 9 heuristically suggests the operation of the device, which includes two conductive planes 29, 30 and a container 31 ~~between them~~ 31. The conductive planes served as a potential detector, with minimum deflection of the particle, by detecting change in the ~~electric~~electrical potential between the planes due to the presence of the charged particle. A particle 32 can be switched between two states. ~~in~~ In one states, the particle 32 ~~move~~ moves to a region between the two planes 29, 30; in the second state, the particle ~~is moving~~ moves outside the region between the two planes 29, 30. In this embodiment, the movement is ~~translatk~~ translated into movement of the particle and not into wave function expansion as in the previous embodiments. The two states are detected by the difference in the charge ~~potentials~~ potential values between the two planes 29, 30.

~~Fourth~~ A fourth preferred embodiment ~~is a~~ consists of the switching device illustrated in ~~fig~~ Fig. 10?

The device ~~include~~ includes a conductive element 33, ~~and an~~ electric field screening element 34 with an unscreened region 34a, wherein the particle wave function can influenced the charge current of element 33 near element 34a.

The operation of the device is heuristically suggested by a first state 35 ~~when~~, in which the particle wave function size is not large enough to be in the unscreened region ~~of~~ 34a, and a second state 36 ~~when~~, in which the particle wave function is large enough to be at in the unscreened region 34a as well, thereby influencing the electric current in element 33. The two switching states are determined by the electric current value in element 33. Each of the two current values indicates a different device state.

An experimental configuration in the super-conducting temperature region related to

embodiment 2 and 4 was the second and fourth embodiments described above has been fabricated, by M. Avinun-Kalish et al. and reviewed by professional referees-Phys Rev Lett 92 (2004). The operation of the experimental configuration is suggested by a quantum dot containing electrons as in the first region in the fourth embodiment 4, next described above. Next to the quantum dot is a region area-confined by two leads, which serves as the second region in the fourth embodiment 4-a-described above. A quantum point contact serves as a detector, since its conductance is changed by the electronic potential in the quantum dot system as the conducting element in the fourth embodiment 4-described above. The system structure includeincludes confinement in the two dimensional electron gas 53 nm below the surface, areal electron density  $3.3 \times 10^{11} \text{ cm}^{-2}$ , mobility of  $1.6 \times 10^6 \text{ cm}^2/\text{Vs}$  at 4.2-Kelvin-°K. The confinement is provided by negatively biased metallic gates deposited on the surface of GaAs-AlGaAs heterojunction embedding the 2DEG. By measuring the detector conductance at different values of drain voltages on the detector:  $V_{\text{sub-d}} = 1.5 \text{ mV}$ ,  $V_{\text{sub-d}} = V_d = 1.5 \text{ mV}$ ,  $V_d = 1.25 \text{ mV}$ ,  $V_{\text{sub-d}} - V_d = 0.9 \text{ mV}$ , for two temperature  $T_{\text{sub-k1}}$  equal temperatures:  $T_{\text{k1}} = 41 \text{ micro-}\mu\text{eV}$  and  $T_{\text{sub-k2}}$  equals  $T_{\text{k2}} = 12 \text{ micro-}\mu\text{eV}$ , a correlation between the quantum dot temperature and the detector conduction was experimentally verified that. That correlation result-results from kinetic energy gained by the increase in temperature raise-that, which expanded the electron wave function -from a-the first region of the quantum dot to the second region -in the device as well, thereby influencedinfluencing the current in the wire detector. The size of the electronic wave function is described in the paper as linearly proportional to FermiFermi velocity, which is proportional to the-temperature and related -to electron kinetic energy.

FifthA fifth preferred embodiment is-a-consists of the switching device described in fig-illustrated in Fig. 11

consist of-. The device consists of repulsive electricelectrical potential contacts 37, 38 and a particle wave function 39.

The operation of the device -is heuristically suggested in fig-11Fig. 11 by repulsive electricelectrical potential contacts 37, 38 which create an-electric-a repulsive electrical potential on a particle wave function 39 between them. The particle size is depends on the repulsive potential value; the larger is-the repulsive potential value, the smaller-become the particle wave function size, this becomes. This method of changing the wave function size is different from -the method described in the previous embodiments-and; it is based on repulsive forces from the two charge planes towards the particle container. By reducing the repulsive potential value, the particle

wave function size expands, thus achieving two states denoted by two particle wave function sizes. To revert to the initial state, the repulsive potentials are ~~reverted to~~ restored to their initial value and the particle wave function ~~returned~~ returns to its initial size. ~~Referring to fig.~~ With reference to Fig. 11a, the repulsive potentials of ~~element~~ elements 37, 38 are directed toward the particle wave function 39 in the container, which reduces the wave function size. ~~Referring to fig.~~ With reference to Fig. 11b, the repulsive potential is reduced due to the repulsive potentials of ~~element~~ elements 37, 38 and the particle wave function 39 is expanded, corresponding to the second state of the device. The detector ~~determined~~ determines the state ~~could~~ may be, for example, any of the detectors described in the previous embodiments.

~~Device~~ The device in Figure 12 ~~contained~~ includes two adjacent ~~regions~~ regions 40, 41, a particle wave function is denoted by diagonal ~~stripes~~ stripes and a detector 43.

The operation of ~~the~~ device is heuristically suggested in ~~fig~~ Fig. 12: the first ~~switched~~ switching state in Fig. 12a is denoted by a particle wave function in a single region 41 in the container 41; the second ~~switched~~ switching state in figure Fig. 12b is denoted by an expanded particle wave function located in ~~region~~ regions 40 and 41. The detection method 43 is ~~may~~ be, for example, any of the ~~method~~ detectors described in the previous embodiments. The methods for ~~change~~ changing the particle energy ~~can~~ may be any of the ~~method~~ methods described in the present patent.

~~Following embodiment describe in more details the devices~~ The following embodiment describes, in greater detail, the construction of the device in the present invention.

Figure. 13 ~~Related~~ refers to the first and fourth embodiments. ~~Particle described above.~~ The particle wave function can be in one region, or expanded ~~can be expanded~~ to a second region ~~as well, as suggested in the first embodiment;~~ the switching states are detected by an electrical conductor, as suggested in first ~~the fourth embodiment, the switched state are detected by an electric conductor as suggested in the fourth embodiment.~~ Switching. A switching device, generally denoted 50, is schematically described in ~~fig~~ illustrated in Fig. 13. Device 50 ~~include~~ includes a layer 52 of silicon with phosphorous ~~depants~~ dopant concentration of  $40 \times 10^{17}$  ~~centimeters sup~~ cm<sup>-3</sup>, an undoped Si ~~silicon~~ silicon layer 54, silicon oxide insulators ~~insulator layers 56, 58, an undoped Si~~ insulator layers 56, 58, an undoped Si ~~silicon layer 58, Aluminum-aluminum-based~~ silicon layer 58, Aluminum-aluminum-based ~~metallic contacts 60, 62, 68, 70, a silicon oxide insulators~~ metallic contacts 60, 62, 68, 70, a silicon oxide insulator layer 64, ~~Aluminum and an aluminum conductor 66.~~ Aluminum and an aluminum conductor 66. Layers 52 have a ~~cross-section of 4 microns by~~ cross-section of 4 microns by ~~2 microns and a thickness of 200-angstrom thickness units.~~ 2 microns and a thickness of 200-angstrom thickness units.

The operation of the device is heuristically suggested in Fig. 13. A voltage bias is applied to contact 60-ef, which has a negative charge (relative to contact 62-ef, which has a positive charge), without inserting electrons into layer 52. The potential difference increaseincreases the kinetic energy in the n-type electron-electrons inside layer 52, then electrons; the electron wave function expand-expands into silicon layer 54; the expanded electricelectrical charge distribution in layer 54 is-changed-changes the potential difference between metallic contacts 68, 70; said contactcontacts are connected in parallel to Aluminumaluminum conductor 66, thereby changing the conduction current in Aluminumaluminum conductor 66-is-changed.

SixthA sixth preferred embodiment is a switching device, generally denoted 80, which is describedillustrated in fig-Fig. 14 and is related to the fourth embodiment. ExpandedExpanded wave function influenceinfluences the conduction on a near-by conducting channel. Device 80 is-consistconsists of -82-a back source layer -82, a layer 84 is-of doped silicon layer with boron -atoms, 86-is-an inversion layer-88-is-86, a p-type source region-90-is-88 made of silicon with boron dopants, a p-type drain region, layers-88, 90 are-made of -silicon with boron dopants-92-is, a silicon -oxide insulator -94-is92, a polysilicon gate, 94, silicon oxide insulator layers 96, 98-are silicon-oxide insulator layers, and aluminum metallic contacts 100, 102-are Aluminum-metal contacts.

The operation of the device is heuristically suggested in by-Fig. 14-. A voltage of 3 voltvolts is biased through 100-source positive-potential100 to 102-drain negative potential-102; electrons do not enter or exit the gate at any time due to the insulating layers 96, 98.- A voltage of 0.7 volt-initiated-volts initiates the polarization process in gate 94. The -gate electrons are-moving-move in the voltage direction-coursing, causing expansion of the electron wave function due to the gain of -kinetic energy, which increase-increases the charge distribution and increaseincreases the effective electricelectrical potential in 94-that-attracted-, thus attracting hole conduction from the-source 88 towards gate 94 throughvia inversion layer 86.

Device 80 could be fabricated by means of the following steps of the method set forth in the second preferred embodiment-method:

(a) An N-n-type silicon wafer 82 is doped with phosphorus atoms-82-, concentration of  $10^{15}$  sup 1-5 centimeters-sup- $10^{15}$  cm<sup>-3</sup>, thickness 0.5 micron-microns.

(b) A layer of silicon dioxide (SiO<sub>2</sub>) 92-, typically 1 micron thick, is grown over the

wafer surface at temperature of  $1100 \pm 50^\circ\text{C}$ , to protect the surface served which serves as a barrier to dopants during the remainder of processing. Photoresist is deposited onto the surface of the wafer and spun to achieve an even distribution of the required thickness.

(c) ~~Photoresist~~ The photoresist layer is exposed to ultraviolet light through a mask, which defines ~~Regions~~ the regions into which diffusion is to take place. Areas exposed to UV radiation are ~~polymerised~~ polymerized. The areas required for diffusion are shielded by the mask and ~~remained~~ remain unaffected.

(b) ~~Thin~~

~~(d)~~ The exposed areas are etched away together with the underlying silicon dioxide to expose the wafer surface in the window defined by the mask.

(f) ~~Thin~~

~~(e)~~ A thin layer of  $\text{SiO}_2$  ~~92~~, 0.1 micron thickness ~~92~~ 1 micron thick, is grown over the entire chip surface. Polysilicon is deposited on top of the gate oxide to form the gate structure ~~Polysilicon~~. A polysilicon layer ~~94~~ of, 0.4 micron thickness, doping polysilicon with a phosphorus atom ~~donat~~ dopant concentration of  $10^{16}$  per centimetre ~~sup~~  $10^{16} \text{ cm}^{-3}$  are, is deposited by Chemical Vapor Deposition (CVD) at a temperature of  $1230 \pm 50^\circ\text{C}$ .

(g) ~~Thin~~

~~(f)~~ The thin oxide layer is removed to expose areas into which ~~Pp~~-type impurities are to be diffused to form the source 88 and drain 90 regions. The diffusion is processed by gas flow ~~containing~~ P containing p-type impurity ~~Boron~~ boron dopants to regions 88 and 90 regions, concentration of  $10^{17}$  per centimetre ~~sup~~  $10^{17} \text{ cm}^{-3}$  over the surface at high temperature.

~~surface at high temperature.~~

(h) ~~Thick~~

~~(g)~~ A thick oxide ( $\text{SiO}_2$ ) layer is grown over the entire wafer again, masked with photoresist and etched to expose selected areas over the polysilicon gate and the source/drain regions 88, 90, where the contact connections are made.

(i) ~~Thin layer~~

~~(h)~~ A thin later of  $\text{SiO}_2$  of, 0.1 micron thick, is grown over the entire chip surface. Aluminium ~~Aluminum~~, typically 1 micron thick, is deposited over the entire wafer surface, thickness typically 1 micron. Metal. The metal layer is masked and etched to form the required interconnection pattern. A passivating oxide (over-glass oxide) is deposited to protect the wafer pattern; the contact holes are patterned for device pad points. ~~Wafer back is metallised~~ The back of the wafer is metallized for substrate connection.

SeventhA seventh preferred embodiment is a switching device, generally denoted 80110, which is illustrated in fig. 15theFig. 15. The device has a structure similar strietur-to the second embodiment, except that the gate have has two charged eontaet contacts on either side with the same charge sign. In a-the case where both eontaet contacts have negative potential-the eontaet eontraeted, the contacts contract the electron wave function inside the gate. In athe case where both eontaetcontacts have positive potential, the contacts expanded the electron wave function inside the gate.

Device 110 eonsistconsists of a back source layer 112, a layer 114 of doped silicon layer with phosphorus atoms, a silicon oxide insulator 116-is silicon oxide insulator, a p-type source region 118 regionmade of p-type sourceesilicon with Boronboron dopants, region-120 a p-type drain dopedregion 120 made of silicon with boron atoms-122 isdopants, a polysilicon gate 122 with phosphorus dopants, silicon oxide insulator layers 124, 126-are silicon oxide insulator layers, and aluminum metallic gate contacts 128, 130 are Aluminum metal gate contact-withhaving the same charge sign.

The operation of the device is heuristically suggested in by Fig. 15. A voltage of 3 voltvolts is biased through +18-source to118 to drain 120-drain; electrons do not enter or exit the gate at any time due to the insulating layers 124, 126.- A positive voltage of 0.6 voltvolts on both eontaets-128, 130 eontaets-expandedexpands the electrons wave function inside gate 122, which increased-increases the charge distribution and increasedincreases the effective electricelectrical potential in gate 122-and-attracted, thus attracting hole conduction from the-source 118 towards the gate.

TheDevice 110 could be fabricated by means of the following steps of the method set forth in the second preferred embodiment-method may fabricate device 110:

(a) An N-n-type silicon wafer 112 is doped with phosphosphosphorus atoms, +12, concentration of 10-sup 15-centimeters-sup- $10^{15} \text{ cm}^{-3}$ , thickness 0.5 microns.

-(b) A layer of silicon dioxide ( $\text{SiO}_2$ ) 116, typically 1 micron thick, is grown over surface-of the wafer at temperature-of 1100oC to protects-surface, acted as at temperature of 1100°C, to protect the surface which serves as a barrier to dopants during the remainder of processing. Photoresist is deposited onto the surface of the wafer and spun to achieve an even distribution of the required thickness.

-(c) Photoresist-The photoresist layer is exposed to ultraviolet light through a mask,

which defines the regions into which diffusion is to take place together with the transistor channels. Areas exposed to UV radiation are ~~polymerised~~ polymerized.

(d) The exposed areas are etched away together with the underlying silicon dioxide to expose the wafer surface in the window defined by the mask.  
~~dioxide to expose the wafer surface in the window defined by the mask.~~

~~(f) Thin~~

(e) A thin layer of  $\text{SiO}_2$  (~~112, 0.1 micron typical~~) 1121 micron thick, is grown over the entire chip surface. Polysilicon is deposited on top of the gate oxide and ~~formed to form the gate structure 122, then~~. A phosphorus atom dopant concentration of ~~40 sups 16 centimetre sup~~  $10^{16} \text{ cm}^{-3}$  ~~are~~, is deposited by Chemical Vapour deposition Vapor Deposition (CVD) at a temperature of 1230°C.

~~(CVD) on temperature of 1230-0C.~~

~~(g) P+ Source/Drain - Further~~

~~(f) P+ source/drain: further photoresist coating and masking allows enables patterned polysilicon. Thin~~

(g) The ~~thin~~ oxide layer is removed to expose areas into which Pp-type impurities are to be diffused and formed to form the source 118 and drain 120 -regions. The diffusion is processed by ~~gas flow contained~~ p-type impurity Boron boron dopants into regions 118 and 120-regions, concentration of ~~40-sup 17 centimetre sup~~  $10^{17} \text{ cm}^{-3}$  over the surface at high temperature.

(h) ~~Thick~~ A thick oxide ( $\text{SiO}_2$ ) layer is grown over the entire wafer again:

~~Masked~~, masked with photoresist and etched to expose selected areas over the polysilicon gate and the source/drain regions 118, 120, where the contact connections are to be made.

(i) ~~Thin layer~~ A thin later of  $\text{SiO}_2$ , 0.1 micron ~~typical~~ thick, is grown; over the entire chip surface. ~~Aluminium of Aluminum, typically 1 micron thick,~~ is deposited over the entire wafer surface. ~~Metal~~. The metal layer is masked and etched to form the required interconnection pattern. A passivating oxide (over-glass oxide) is deposited to protect the wafer pattern; the contact holes are patterned for device pad points. The back of the wafer is ~~metallised~~ metallized for substrate connection.



## MODIFICATION AND ADVANTAGES

The dimensions and materials of the preferred embodiment switching devices can be greatly varied while still preserving the mode of operation. The silicon system could be replaced with other systems such as gallium-arsenide GaAs, GaN, etc. The devices could be fabricated from thin layers of glasses, insulators, metals, etc. and still provide the operation as in the preferred embodiments. Instead of phosphorus and boron gates, source and drain dopants could be, for example, n-type: arsenic, antimony or p-type: gallium, ~~berin~~ boron; the concentration of the dopants could be changed also. Insulation materials and contacts can be greatly varied.

Holes could be the carrier instead of electrons ~~could be the carrier~~, or even both holes and electrons transported in opposite directions simultaneously. Either dimensional changes or material changes or combinations could change the particles energy levels.

Various geometries are available, such as interdigitated base and emitter, source and drain, multiple emitters, multiple collectors, multiple bases, multiple gates, multiple sources, multiple drains, multiple detectors and so forth.

Different ~~value of~~ current, voltage or temperature values could be embedded in the device.

The invention deals with new switching methods that included ~~embedde~~ embedding in different structures, devices and fabrication methods and could be integrated ~~to a structure~~ into a structure containing more than one device.

The switching speed and device size could be adjusted ~~so that by~~ through the use of various device ~~strutures~~ structures, specifications and materials.

Any of the switching methods described in this patent could be combined with any of the detection methods described in this patent; in addition, other detection methods could be embedded in the device.

Other triggered switching methods ~~for example~~, such as ultrasound pulses, could be embedded in the device.

The device can be operated in either the enhancement mode or ~~in~~ the depletion mode by adjusting the structure and materials.

The advantages of the preferred embodiments and modifications include high switching speed, small devices, low energy consumption and low heat emission.